

LIET 152 2nd Exam	2011. 11. 12	Dept. :	Student # :	Name :
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1. Define the following terms briefly.

- ① rate-determining step (1 pt)
- ② heterogenous catalyst (1 pt)
- ③ Le Chatelier's principle (1 pt)
- ④ major species (1 pt)
- ⑤ conjugate acid-base pair (1 pt)
- ⑥ polyprotic acid (1 pt)

2. For the reaction $2 A(g) + B(g) \rightarrow 3 C(g)$,

- ① Determine the expression for the rate of the reaction with respect to each of the reactants and products. (3 pt)

- ② When A is decreasing at a rate of 0.100 M/s, how fast is B decreasing? How fast is C increasing? (3 pt)

3. The decomposition reaction of NOBr is second order in NOBr, with a rate constant at 20°C of $25 \text{ M}^{-1}\text{min}^{-1}$. If the initial concentration of NOBr is 0.025 M, find

- ① the time at which the concentration will be 0.010 M. (3 pt)

- ② the concentration after 125 min of reaction. (3 pt)

4. The reaction of CO with Cl_2 gives phosgene (COCl_2), a nerve gas used in World War I. Even though the stoichiometry is simple, the mechanism has several steps:



- ① Show that this mechanism gives the correct overall stoichiometry. (4 pt)

- ② What rate law does this mechanism predict? (4 pt)

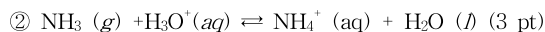
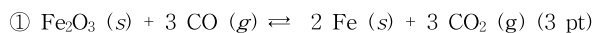
- ③ Identify any reactive intermediates in the mechanism. (5 pt)

5. For the reaction $\text{NO} + \text{O}_3 \rightarrow \text{NO}_2 + \text{O}_2$, the experimental rate law is $\text{Rate} = k[\text{NO}][\text{O}_3]$. Which of the following sets of conditions will give the fastest rate? Explain your choice.

- ① 0.5 mol of NO and 0.5 O_3 in a 2.0-L vessel. (3 pt)

- ② 2.0 mol of NO and 0.1 mol of O_3 in a 1.0-L vessel. (3 pt)

6. State the standard (reference) concentration for each substance appearing in each of the following equilibria.

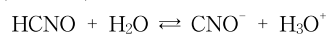


7. Consider the following gas-phase reaction:



Describe four changes that would drive the equilibrium to the left. (6 pt)

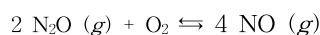
8. Cyanic acid, HCNO, is a weak acid:



The equilibrium concentration of H_3O^+ ions is $1.15 \times 10^{-3} \text{ M}$.

Evaluate K_{eq} . (8 pt)

9. Using thermodynamic data given below, calculate K_{eq} for the following reaction at 298 K and 825 K. (8 pt)



	$\text{N}_2\text{O} (g)$	$\text{O}_2 (g)$	$\text{NO} (g)$
$\Delta G_f^\circ (\text{kJ/mole})$	103.7	0	87.6
$\Delta H_f^\circ (\text{kJ/mole})$	81.6	0	91.3
$S^\circ (\text{J/mol K})$	220.0	205.152	210.8

10. Calculate the pH of $2.5 \times 10^{-2} \text{ M}$ solution of HClO ($K = 4.0 \times 10^{-8}$). (8 pt)

11. For a solution that is 0.0100 M in NH_4NO_3 , do the following:

① Identify the major species. (3 pt)

② Identify the equilibrium that determines the pH. (3 pt)

③ Compute the pH. ($K_b = 1.8 \times 10^{-5}$) (5 pt)

12. Answer the following:

① Among the pair of acid HBrO_3 and HBrO_2 , which is stronger and why? (4 pt)

② Draw Lewis structures of the acids HBrO_3 and HBrO_2 , and use arrows to show electron density shifts that account for their different acid strengths. (4 pt)

13. Hydrazine (N_2H_4) has $K_b = 1.3 \times 10^{-6}$.

① Use Lewis structures to illustrate the equilibrium reaction of K_b . (4 pt)

② Calculate the pH of a $2.00 \times 10^{-1} \text{ M}$ solution of N_2H_4 . (4 pt)

***** 문제 해결에 필요한 상수들 *****

▪ 0 K = -273.15 °C, $K_w = 1.00 \times 10^{-14}$

▪ 기체 상수 $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$

▪ $\Delta G_o = \Delta H^\circ - T\Delta S^\circ$; $\Delta G^\circ = -RT\ln K_{\text{eq}}$